Modified Spline-Based Navigation: Guaranteed Safety for Obstacle Avoidance

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Abstract. Successful interactive collaboration with a human demands mobile robots to have an advanced level of autonomy, which basic requirements include social interaction, real time path planning and navigation in dynamic environment. For mobile robot path planning, potential function based methods provide classical yet powerful solutions. They are characterized with reactive local obstacle avoidance and implementation simplicity, but suffer from navigation function local minima. In this paper we propose a modification of our original spline-based path planning algorithm, which consists of two levels of planning. At the first level, Voronoi-based approach provides a number sub-optimal paths in different homotopic groups. At the second, these paths are optimized in an iterative manner with regard to selected criteria weights. A new safety criterion is integrated into both levels of path planning to guarantee path safety, while further optimization of a safe path relatively to other criteria is secondary. The modified algorithm was implemented in Matlab environment and demonstrated significant advantages over the original algorithm.

Keywords: Path planning · Safety · Potential field · Voronoi graph

1 Introduction

Contemporary robotic applications target for human replacement in diverse scenarios that spread from social-oriented human-robot interaction [11] and collaboration [13] to automatic swarm control [12] and urban search and rescue in hostile environments [9]. All such applications demand indoor and outdoor autonomous path planning and navigation abilities with simultaneous localization and mapping (SLAM) [2], collaboration with other robots [10] and other functionality.

Path planning distinguishes global and local approaches. While the later operates in a completely unknown environment and robots make immediate decisions that are based on locally available information only, the global approach can access complete knowledge about environment, i.e., robot shape, initial and

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